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Construction and Practice of a Digital Resource-Driven Blended Teaching Model for Engineering Drawing

Yunxia Shi*

School of Mechanical Engineering, University of Shanghai for Science and Technology, Shanghai, China
shyunxia@126.com
**Corresponding author*

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Abstract: Engineering Drawing is a core foundational course in engineering education. Traditional teaching modes exhibit evident deficiencies in cultivating spatial thinking, efficient use of class time, and timely assignment feedback. Drawing on digital reform practice, this paper integrates SolidWorks 3D courseware, AutoCAD digital assignments, and QR-code-embedded micro-lecture textbooks as core resources to construct a blended teaching model structured around "pre-class micro-lecture self-study — in-class 3D focused instruction — post-class digital evaluation." The model targets three major problems—weak spatial imagination, insufficient class time, and low feedback efficiency—and proposes corresponding digital solutions. Classroom practice validates the effectiveness of the model. Results show significant improvements in students' three-view accuracy, course engagement, and overall satisfaction, providing a replicable digital reform pathway for Engineering Drawing instruction.

1. Introduction

Engineering Drawing is a core foundational course in higher engineering education, responsible for cultivating students' spatial thinking, drawing expression ability, and awareness of technical standards and norms. However, as the construction of "New Engineering" (Xin Gongke) advances and class hours continue to be reduced, the traditional "blackboard + textbook" mode is increasingly unable to meet instructional needs: the contradiction between dense knowledge points and limited class time grows acute, students encounter significant difficulties in developing three-dimensional spatial imagination, and the efficiency of paper-based assignment marking is low with feedback consistently delayed—all of which severely constrain the quality of course instruction [1].

The rapid development of digital education has opened new pathways for Engineering Drawing reform. Software such as SolidWorks can visually present the spatial geometry and projection relationships of parts, effectively compensating for the abstractness of traditional flat-plane instruction; micro-lectures and QR-code-embedded textbooks break temporal and spatial constraints, enabling students to learn independently on demand; digital assignment platforms allow efficient closed-loop management of submission, marking, and data tracking [2]. Drawing on teaching

practice, this paper constructs and implements a digital resource-driven blended teaching model based on existing SolidWorks courseware, AutoCAD courseware, and QR-code micro-lecture textbooks, with the aim of providing a useful reference for the digital reform of similar courses.

2. Key Problems in Traditional Engineering Drawing Instruction

Through a systematic review of Engineering Drawing teaching practice in recent years, three core problems are identified in the current traditional mode. Table 1 presents a systematic comparison between traditional and digital teaching modes.

Table 1: Comparison between traditional and digital teaching modes.

Dimension	Traditional Mode	Digital Mode
Teaching Resources	Static printed textbooks, blackboard	SolidWorks 3D courseware, QR-code micro-lectures, CAD digital assignments
Knowledge Delivery	2D projection drawings, abstract and hard to visualise	Dynamic 3D model demonstrations showing projection relationships intuitively
Class Time Usage	Teacher-centred lecturing; content-dense	Micro-lectures free up class time for focused instruction on key difficulties
Assignment Feedback	Paper-based marking; long cycle; slow feedback	Digital CAD submission; instant verification; errors traceable
Assessment Mode	Single final exam; result-oriented	Process data + summative assessment; diversified evaluation

(1) Difficulty in Cultivating Spatial Imagination. The core challenge of Engineering Drawing lies in the conversion between three-dimensional forms and two-dimensional drawings. Traditional teaching relies on blackboard demonstrations and static drawings, making it difficult for students to build intuitive spatial concepts. Surveys indicate that beginners exhibit consistently high error rates in three-view drawing tasks, particularly for complex features such as intersection lines and interpenetration lines, where classroom instruction proves limited in effectiveness [3].

(2) Contradiction between Insufficient Class Time and Dense Content. Engineering Drawing covers a vast range of knowledge including projection theory, technical standards, part drawings, and assembly drawings, yet class hours are commonly compressed to 32–48 periods. Teachers frequently face the dilemma of "too much to cover" versus "too shallow to master," and the fast classroom pace causes some students to fall behind [4].

(3) Low Assignment Feedback Efficiency. The marking cycle for traditional paper-based assignments typically extends to approximately one week. During this waiting period students have already moved on to new content, so errors go uncorrected and knowledge gaps accumulate. Moreover, paper assignments make it difficult to track the distribution of student errors, preventing teachers from precisely adjusting instructional emphasis in response [5].

3. Construction of the Digital Blended Teaching Model

In response to the three problems above, and drawing on existing digital teaching resources, this paper constructs a blended teaching model structured around "pre-class micro-lecture self-study — in-class 3D focused instruction — post-class digital evaluation." Figure 1 presents the specific solutions and supporting resources corresponding to each problem.

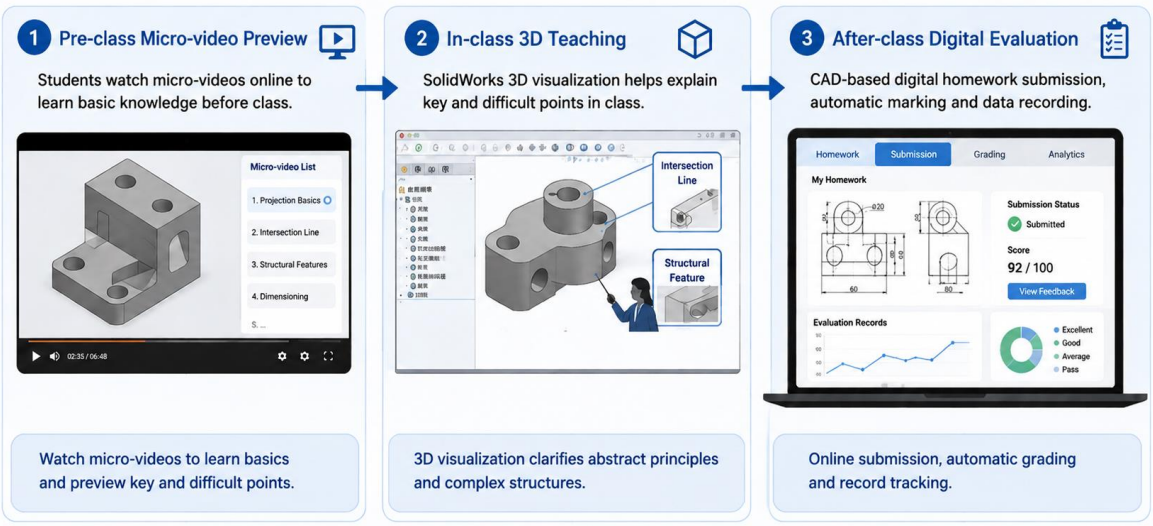

Figure 1: Three-stage Framework of Blended Teaching and Corresponding Digital Teaching Resources

3.1. Using SolidWorks 3D Courseware to Address Spatial Imagination Difficulties

A three-dimensional model library synchronised with the textbook is established in SolidWorks, enabling dynamic linkage demonstration of "3D model — axonometric view — three-view drawing" in the classroom. The instructor can rotate models in real time and switch viewpoints, allowing students to observe intuitively how the projection of a part changes across different directions, transforming the abstract principle of orthographic projection into a visualised dynamic process. For difficult content such as intersection lines and interpenetration lines, the SolidWorks section-cut feature is used to reveal the generation process of cross-sectional shapes, significantly lowering the learning threshold.

3.2. Using QR-Code Micro-Lecture Textbooks to Restructure Class Time

The advantages of existing QR-code micro-lecture textbooks are fully exploited: foundational and memory-based knowledge points (e.g., projection rules, line conventions, dimensioning standards) are pre-placed as micro-lecture videos, requiring students to complete self-study before class and pass a brief platform test to verify preparation. Class time is then concentrated on 3D demonstrations, focused instruction on key difficulties, and interactive discussion, achieving a structural shift from "teacher-led lecturing" to "student self-study + focused classroom instruction" and effectively relieving the pressure of insufficient class hours.

3.3. Using CAD Digital Assignments to Improve Feedback Efficiency

Students are required to submit assignments in AutoCAD file format via the platform for online submission and unified archiving. After marking, the instructor can embed annotated comments directly into the drawing file and return it, allowing students to clearly identify and correct errors at the exact location. Meanwhile, the platform automatically records process data such as submission time and revision count, providing objective evidence for end-of-term comprehensive evaluation and gradually establishing a diversified assessment system combining "ongoing process scores + final examination scores."

4. Teaching Practice Outcomes

The blended teaching model described above has been piloted in Engineering Drawing courses. Through comparative analysis of student learning data before and after implementation, Table 2 presents changes in the main evaluation indicators.

Table 2: Comparison of key indicators before and after teaching reform.

Evaluation Indicator	Before Reform	After Reform	Trend
Three-View Accuracy Rate	~62%	~81%	↑ Significant improvement
Pre-class Study Completion Rate	—	>85%	↑ New indicator
Avg. Assignment Submission Cycle	~7 days	~2 days	↓ Greatly shortened
Overall Course Satisfaction	78/100	91/100	↑ Clearly improved

As shown in Table 2, the three-view accuracy rate increased from approximately 62% to approximately 81% after the reform—a rise of 19 percentage points—demonstrating that the SolidWorks 3D dynamic linkage demonstration has a significant effect on spatial thinking development. The pre-class study completion rate exceeded 85%, indicating that the micro-lecture-based autonomous learning mode was well received by students. The adoption of CAD digital assignments reduced the average submission-and-feedback cycle from approximately 7 days to approximately 2 days, substantially improving the timeliness of error correction. Overall course satisfaction rose from 78 to 91 points, reflecting a broadly positive student response to the digital instructional approach.

It is also worth noting that during implementation some students experienced an initial adaptation period with SolidWorks operations, requiring additional introductory software guidance. Furthermore, the quality of micro-lecture pre-study varied among students, with some engaging only superficially; this can be addressed in future iterations by refining the pre-class testing mechanism.

5. Conclusions

The digital resource-driven blended teaching model constructed in this paper, supported by existing SolidWorks courseware, AutoCAD courseware, and QR-code micro-lecture textbooks, provides a systematic digital solution addressing three core problems in Engineering Drawing instruction: difficulty cultivating spatial imagination, insufficient class time, and low feedback efficiency. Practice results demonstrate that the model effectively improves students' three-view competence, classroom engagement, and overall satisfaction, and holds considerable potential for broader adoption.

Future research will further explore the integration of VR/AR virtual simulation technology to provide a more immersive spatial cognition experience, while continuously optimising the platform's data analytics functions to advance the evaluation system towards greater intelligence and precision, offering sustained support for the deeper digital transformation of Engineering Drawing instruction.

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